**International Journal on Recent Researches in Science, Engineering & Technology (IJRRSET)**

**A Journal Established in early 2000 as National journal and upgraded to International journal in 2013 and is in existence for the last 10 years. It is run by Retired Professors from NIT, Trichy. Journal Indexed in JIR, DIIF and SJIF.**

**Available online at:** www.jrrset.com

ISSN (Print) : 2347-6729
ISSN (Online) : 2348-3105

**Volume 4, Issue 2**
**February 2016.**
**JIR IF : 2.54**
**SJIF IF : 4.334**
**Cosmos: 5.395**

**Received on:** 04.12.2015 **Published on:** 05.02.2016 **Pages :** 28-31

# COLLISION AVOIDANCE AND MITIGATION IN INDUSTRIAL ROBOTICS

**Siddique Ghias Ahmed[a*], S. Pandiyarajan[b]**

Department of Mechatronics Engineering, Agni College of Technology, Chennai 600130, Tamilnadu, India

[a] e-mail: siddique.mec@act.edu.in, [b] e-mail: pandiyarajan.mht@act.edu.in

## ABSTRACT

The complete cycle from the idea of using perception to prevent crashes, to full system development, took over 10 years in this case. The pure *robotics* part of the system is a crucial element, but is only one piece of the development needed to make a useful product. Some active control has already been assumed by today's vehicles. Antilock brakes have been on the market for many years. Traction control systems which control throttle to stop wheel spin are being introduced. Electronic stability control systems take this the next step further, controlling throttle and individual wheel brakes to help in cornering performance. So, gradually, people are willing to cede some control to very reliable automated systems. We can expect this trend to continue.

## BACKUP COLLISIONS

The sensing challenge is to see relatively small objects, such as fence posts or children's toys, while not picking up false alarms from pavement joints or leaves and debris. The sensors used in today's commercial vehicles are piezoelectric ultrasonic sensors, which are inexpensive. However, ultrasonic sensors have well-known limitations. The challenge of developing low-cost, accurate, reliable sensors remains.

## REAR-END COLLISIONS

These are among the most difficult collisions to prevent, with the most challenging sensing conditions. Rearend collisions often happen at high speeds, requiring long-distance sensing of other vehicles (up to 100m at US highway speeds, much longer at the high speeds found on some European roads or for the longer braking distances needed for heavy trucks). That in itself is not too demanding a challenge: the sensed objects in this case are relatively large and have high metal components, so radar and lidar are both feasible sensing modes. The biggest range-sensing challenge is sorting out true targets (slow or stopped vehicles) from false targets (overhead signs or bridges, and side lobes from strong reflectors on the side of the road). It is also important to determine if the sensed vehicle is in the same lane as the smart car, or a different lane. Sensing lane markings at such a large distance is a very difficult challenge; merging lane sensing (often done by vision) with obstacle sensing (by a different sensor) and registering the two to within the resolution of a lane is a daunting task. This technology remains under development through industry and government programs.

## LANE-CHANGE/MERGE COLLISIONS

In the simplest case, the countermeasure to this kind of collision involves short-range sensing to cover the *blind spots* on the rear corners of a vehicle, where it is difficult to see with mirrors. For passenger cars, this area is quite small, and can be covered with a single sonar or radar. Often, the user interface is a warning light placed in the rear-view mirrors; this reinforces good driver behavior of checking mirrors before changing lanes. The sensing challenge for heavy trucks or transit buses is the same as for cars, except that the area not visible in planar mirrors can be much larger.

Fig. 1 Blind Spot Detection

Figure 1 shows examples of blind-spot detection for cars and heavy vehicles. The usual solution is a row of sensors along the side of the vehicle, although scanning lidars or panoramic vision are also used in some experimental applications. The further complication for lane-change warnings is in high-speed driving, where it is important to look not just adjacent to the vehicle but a long way to the rear, to find overtaking vehicles with high relative speeds. Recently a commercial product has been brought to market.

**PEDESTRIAN COLLISIONS**

Pedestrians are particularly important to detect, because pedestrians are much more vulnerable than people in vehicles; as discussed earlier they are also unfortunately relatively difficult to detect and very hard to predict. Just detecting a pedestrian is not sufficient. In transit operations, for instance, a bus operates close to pedestrians much of the time. To do meaningful collision warning, it is important to detect the pedestrian, detect their current path, look for cues such as crosswalks or curb edges that modify the probability of the pedestrian's trajectory, and match all of these factors with the predicted trajectory of the vehicle. It is crucial to tune the warning system to produce few false alarms while not missing real alarms. A particularly dangerous situation is pedestrians slipping and falling underneath a bus: these are very dangerous situations, but very difficult to detect in time to warn the driver. For these reasons, automotive manufacturers have worked on products such as night vision to enhance driver perception.

**INTERSECTION COLLISIONS**

Intersection collisions are particularly difficult to prevent because they often involve challenging sensing scenarios. Many of these collisions involve occluded vision, with lines of sight blocked either by large vehicles or by adjacent buildings. They also often involve high closing rates from oblique angles, making it necessary to see a long distance with a very wide field of view. The solution usually proposed is to add intelligence to the infrastructure, either in fixed sensing (such as radars looking down each approaching road) or in some kind of radio relay that takes data from approaching smart cars and passes it to other approaching vehicles. None of these solutions is particularly attractive: the large number of intersections makes it difficult to envision any universal solution.

## OTHER OBSTACLE COLLISIONS

Vehicles have collisions with many things other than other vehicles and pedestrians: animals (deer, dogs, cats), car parts (tire carcasses, rusted-out exhaust systems), cargo that falls off of trucks, construction debris, etc. Warning drivers about these kinds of objects on the roadway is a challenging task. A piece of construction timber on the roadway may be large enough to do significant damage to a car, but be small enough to be difficult to see, and be invisible to radar. Some interesting work has been done with high-resolution stereo vision, with polarimetric radar, and with high-resolution scanning laser range-finders. However, in general this remains a difficult problem.

## OTHER ACTIONS

Besides warning the driver, there are other actions that an intelligent vehicle can take short of assuming control. If a collision is inevitable, particularly from the side of the vehicle where there is limited crush space, the system can brake and deploy airbags even before physical contact. Of course, such a system would have to be nearly 100% reliable. More simply, if the system senses an imminent front collision, it can preload the power brakes, saving fractions of a second in brake reaction time. The driver must still actuate the brakes, but the onset of hard braking can be much quicker. At 100 km/h, a 0.1 s saving in braking actuation saves approximately 3m of stopping distance, which can be the difference between a severe rear-end collision and a much lighter crash. Such systems are being introduced into the high-end market by all the major automotive manufacturers.

## COLLISION AVOIDANCE

The next step beyond emergency braking is an automated system. Such systems have several advantages over a human driver: much quicker reaction times, access to sensors such as individual wheel speeds and slips plus external sensors such as radars or lidars, access to individual brake controls and other controls, and so forth. So, if the system had ideal situational awareness, it could in many cases do a better job of avoiding a collision than a human could. This is still a very difficult area for implementation, however. First of all, the human has access to higher-level knowledge: the driver may be watching the behaviors of other cars, may make eye contact with pedestrians or drivers, may be watching a policeman directing traffic, etc. So it may be that a manoeuvre that, to the system, looks like the best way to prevent the collision is actually the wrong action to take. Secondly, in most countries, as soon as the vehicle takes control there is a shift in the liability for any resulting crash from the driver to the manufacturer. So there is a great reluctance to take active control. An alternative approach recently developed is to observe the environment state with lidar, and monitor the dynamic vehicle state to determine whether the accident is unavoidable. If the driver can no longer take corrective action, that is, brake or turn away safely, then emergency braking occurs [51.11]. For now, however, active collision avoidance remains a research area, with significant questions of reliability, human factors, and liability. Combining perception with control gives partial automation for specific tasks, such as adaptive cruise control, lane keeping, assisted parking, and slow driving in stop-and-go situations.

## CONCLUSION

The general public will become increasingly accustomed to intelligent systems – sensors and communications on vehicles. The only showstopper in the large-scale deployment of robotics technologies in the automobile field is the ability of the industry to deliver the technologies with total safety, which focus attention on the problems of failsafe systems and their certification.

The rail and aerospace industries have solved these problems but in a very different environment. In these industries, the cost of safety for each vehicle can be much higher than in a car or a bus and the operational environment is also quite different, with professionals operating and maintaining the system. Manufacturers will slowly develop experience in reliability and cost engineering, and governments will gradually work out liability issues. For these reasons, systems that put the driver in the loop of new automation technologies will be the initial focus of development.

## REFERENCES

[1] E.D. Dickmanns: The development of machine vision for road vehicles in the last decade, Proc. IEEE Intelligent Vehicles Symposium 2002, Vol. 1, Paris (2002) pp. 268–281

[2] A. Broggi, M. Bertozzi, A. Fascioli, G. Conte: Automatic Vehicle Guidance: The Experience of the ARGO Autonomous Vehicle (World Scientific, Singapore 1999)

[3] C.E. Thorpe (Ed.): Vision and Navigation: The Carnegie Mellon Navlab (Kluwer Academic, Dordrecht 1990)

[4] D. Pomerleau, T. Jochem: Rapidly adapting machine vision for automated vehicle steering, IEEE Expert, **11**(2) 19-27 (1996), Special Issue on Intelligent System and their Applications

[5] US Department of Transport: Intelligent Transportation Systems, Saving Lives Through Advanced Vehicle Safety Technology: Intelligent Vehicle Initiative Final Report (2005) Publication No. FHWA-JPO-05-057. http://www.its.dot.gov/ivi /ivi.htm

[6] K. Iagnemma, M. Buehler (Eds.): Special Issues on the DARPA Grand Challenge, J. Field Robot. **23(**8,9) (2006), www.darpa.mil/grandchallenge

[7] L. Vlacic, M. Parent, F. Harashima: EDS Intelligent Vehicle Technologies, Theory and Applications (Butterworth-Heinemann, Oxford 2001)

[8] Micron: Supplier of imaging sensors including infra-red (Micron, Boise 2007), www.micron.com

[9] Valeo: Supplier of automotive technology – including ultrasonic parking assistance systems www.valeo.com

[10] Hella: Supplier of automotive 24-GHz radar sensors www.hella.com

[11] Ibeo: Supplier of automotive laser sensors www.ibeo-as.com

[12] Mobileye: Supplier of automotive computer vision sensors www.mobileye.com

[13] Seeing Machines: Supplier of driver state vision systems www.seeingmachines.com

[14] Leearmstrong: Support site for Dedicated Short Range Communications (DSRC) discussions www.leearmstrong.com

[15] Sae: ISO/TC204 Transport Information and Control Systems (TICS), Working Group 16, Wide Area Communications/Protocols and Interfaces http://www.sae.org/technicalcommittees/tc204wg16.html